CLAIMS

1. A method of interpolation in video coding in which an image comprising pixels arranged in rows and columns and represented by values having a specified dynamic range, the pixels in the rows residing at unit horizontal locations and the pixels in the columns residing at unit vertical locations, is interpolated to generate values for sub-pixels at fractional horizontal and vertical locations, the fractional horizontal and vertical locations being defined according to $1/2^x$, where x is a positive integer having a maximum value N, the method comprising:

a) when values for sub-pixels at $1/2^{N-1}$ unit horizontal and unit vertical locations, and unit horizontal and $1/2^{N-1}$ unit vertical locations are required, interpolating such values directly using weighted sums of pixels residing at unit horizontal and unit vertical locations;

b) when values for sub-pixels at $1/2^{N-1}$ unit horizontal and $1/2^{N-1}$ unit vertical locations are required, interpolating such values directly using a choice of a first weighted sum of values for sub-pixels residing at $1/2^{N-1}$ unit horizontal and unit vertical locations and a second weighted sum of values for sub-pixels residing at unit horizontal and $1/2^{N-1}$ unit vertical locations, the first and second weighted sums of values being calculated according to step (a); and

c) when a value for a sub-pixel situated at a $1/2^N$ unit horizontal and $1/2^N$ unit vertical location is required, interpolating such a value by taking a weighted average of the value of a first sub-pixel or pixel situated at a $1/2^{N-m}$ unit horizontal and $1/2^{N-n}$ unit vertical location and the value of a second sub-pixel or pixel located at a $1/2^{N-p}$ unit horizontal and $1/2^{N-q}$ unit vertical location, variables m, n, p and q taking integer values in the range 1 to N such that the first and second sub-pixels or pixels are located diagonally with respect to the sub-pixel at $1/2^N$ unit horizontal and $1/2^N$ vertical location.

2. A method according to claim 1 wherein a first and a second weight are used in the weighted average referred to in (c), the relative magnitudes of the weights being inversely proportional to the (straight-line diagonal)

proximity of the first and the second sub-pixel or pixel to the sub-pixel at $1/2^N$ unit horizontal and $1/2^N$ vertical location.

3. A method according to claim 2, wherein in a situation where the first and the second sub-pixel or pixel are symmetrically located with respect to (equidistant from) the sub-pixel at $1/2^N$ unit horizontal and $1/2^N$ vertical location, the first and second weights have equal values.

4. A method according to claim 1 in which the first weighted sum of values for sub-pixels residing at $1/2^{N-1}$ unit horizontal and unit vertical locations in step b) is used when a sub-pixel at $1/2^{N-1}$ unit horizontal and $1/2^N$ unit vertical location is required.

5. A method according to claim 1 in which the second weighted sum of values for sub-pixels residing at unit horizontal and $1/2^{N-1}$ unit vertical locations in step b) is used when a sub-pixel at $1/2^N$ unit horizontal and $1/2^{N-1}$ unit vertical location is required.

6. A method according to claim 1 in which, when values for sub-pixels at $1/2^N$ unit horizontal and unit vertical locations, and $1/2^N$ horizontal and $1/2^{N-1}$ vertical locations are required, interpolating such values by taking the average of the values of a first pixel or sub-pixel located at a vertical location corresponding to that of the sub-pixel being calculated and unit horizontal location and a second pixel or sub-pixel located at a vertical location corresponding to that of the sub-pixel being calculated and $1/2^{N-1}$ unit horizontal location.

7. A method according to claim 1 in which, when values for sub-pixels at unit horizontal and $1/2^N$ unit vertical locations, and $1/2^{N-1}$ unit horizontal and $1/2^N$ unit vertical locations are required, interpolating such values by taking the average of the values of a first pixel or sub-pixel located at a horizontal location corresponding to that of the sub-pixel being calculated and unit

vertical location and a second pixel or sub-pixel located at a horizontal location corresponding to that of the sub-pixel being calculated and $1/2^{N-1}$ unit vertical location.

8. A method according to claim 1 in which values for sub-pixels at $1/2^N$ unit horizontal and $1/2^N$ unit vertical locations are interpolated by taking the average of values of a pixel located at a unit horizontal and unit vertical location, and a sub-pixel located at a $1/2^{N-1}$ unit horizontal and $1/2^{N-1}$ unit vertical location.

9. A method according to claim 1 in which values for sub-pixels at $1/2^N$ unit horizontal and $1/2^N$ unit vertical locations are interpolated by taking the average of values of a sub-pixel located at a $1/2^{N-1}$ unit horizontal and unit vertical location, and a sub-pixel located at a unit horizontal and $1/2^{N-1}$ unit vertical location.

10. A method according to claim 1 in which values for half of the sub-pixels at $1/2^N$ unit horizontal and $1/2^N$ unit vertical locations are interpolated by taking the average of a first pair of values of a sub-pixel located at a $1/2^{N-1}$ unit horizontal and unit vertical location, and a sub-pixel located at a unit horizontal and $1/2^{N-1}$ unit vertical location and values for the other half of the sub-pixels at $1/2^N$ unit horizontal and $1/2^N$ unit vertical locations are interpolated by taking the average of a second pair of values of a pixel located at a unit horizontal and unit vertical location, and a sub-pixel located at a $1/2^{N-1}$ unit horizontal and $1/2^{N-1}$ unit vertical location.

11. A method according to claim 10 in which values for sub-pixels at $1/2^N$ unit horizontal and $1/2^N$ unit vertical locations are alternately interpolated for one such sub-pixel by taking the average of a first pair of values of a sub-pixel located at a $1/2^{N-1}$ unit horizontal and unit vertical location, and a sub-pixel located at a unit horizontal and $1/2^{N-1}$ unit vertical location and values and for a neighbouring such sub-pixel by taking the average of a second

pair of values of a pixel located at a unit horizontal and unit vertical location, and a sub-pixel located at a $1/2^{N-1}$ unit horizontal and $1/2^{N-1}$ unit vertical location.

12. A method according to claim 11 in which the sub-pixels at $1/2^N$ unit horizontal and $1/2^N$ unit vertical locations are alternately interpolated in a horizontal direction.

13. A method according to claim 11 in which the sub-pixels at $1/2^N$ unit horizontal and $1/2^N$ unit vertical locations are alternately interpolated in a horizontal direction.

14. A method according to claim 1 in which when values for some sub-pixels at $1/2^N$ unit horizontal and $1/2^N$ unit vertical locations are required, such values are interpolated by taking the average of a plurality of nearest neighbouring pixels.

15. A method according to claim 1 in which N equals an integer selected from a list consisting of the values 2, 3, and 4.

16. A method according to claim 1 in which in at least one of step a) and step b) interpolating sub-pixel values directly using weighted sums involves the calculation of an intermediate value for the sub-pixel values having a dynamic range greater than the specified dynamic range.

17. A method according to claim 14 in which the intermediate value for a sub-pixel having $1/2^{N-1}$ sub-pixel resolution is used the calculation of a sub-pixel value having $1/2^N$ sub-pixel resolution.

18. A method of interpolation in video coding in which an image comprising pixels arranged in rows and columns and represented by values having a specified dynamic range, the pixels in the rows residing at unit horizontal

locations and the pixels in the columns residing at unit vertical locations, is interpolated to generate values for sub-pixels at fractional horizontal and vertical locations, the method comprising:

a) when values for sub-pixels at half unit horizontal and unit vertical locations, and unit horizontal and half unit vertical locations are required, interpolating such values directly using weighted sums of pixels residing at unit horizontal and unit vertical locations;

b) when values for sub-pixels at half unit horizontal and half unit vertical locations are required, interpolating such values directly using a weighted sum of values for sub-pixels residing at half unit horizontal and unit vertical locations calculated according to step (a); and

c) when values for sub-pixels at quarter unit horizontal and quarter unit vertical locations are required, interpolating such values by taking the average of at least one pair of a first pair of values of a sub-pixel located at a half unit horizontal and unit vertical location, and a sub-pixel located at a unit horizontal and half unit vertical location and a second pair of values of a pixel located at a unit horizontal and unit vertical location, and a sub-pixel located at a half unit horizontal and half unit vertical location.

19. A method of interpolation in video coding in which an image comprising pixels arranged in rows and columns and represented by values having a specified dynamic range, the pixels in the rows residing at unit horizontal locations and the pixels in the columns residing at unit vertical locations, is interpolated to generate values for sub-pixels at fractional horizontal and vertical locations, the fractional horizontal and vertical locations being defined according to $1/2^x$ where x is a positive integer having a maximum value N, the method comprising:

a) when values for sub-pixels at $1/2^{N-1}$ unit horizontal and unit vertical locations, and unit horizontal and $1/2^{N-1}$ unit vertical locations are required, interpolating such values directly using weighted sums of pixels residing at unit horizontal and unit vertical locations;

b) when a value for a sub-pixel at a sub-pixel horizontal and sub-pixel vertical location is required, interpolating such a value directly using a choice of a first weighted sum of values for sub-pixels located at a vertical location corresponding to that of the sub-pixel being calculated and a second weighted sum of values for sub-pixels located at a horizontal location corresponding to that of the sub-pixel being calculated.

20. A method according to claim 1 in which the sub-pixels used in the first weighted sum are sub-pixels residing at $1/2^{N-1}$ unit horizontal and unit vertical locations and the first weighted sum is used to interpolate a value for a sub-pixel at $1/2^{N-1}$ unit horizontal and $1/2^{N}$ unit vertical location.

21. A method according to claim 1 in which the sub-pixels used in the second weighted sum are sub-pixels residing at unit horizontal and $1/2^{N-1}$ unit vertical locations and the second weighted sum is used to interpolate a value for a sub-pixel at $1/2^{N}$ unit horizontal and $1/2^{N-1}$ unit vertical location.

22. A method according to claim 1 in which when values for sub-pixels at $1/2^{N}$ unit horizontal and $1/2^{N}$ unit vertical locations are required, they are interpolated by taking the average of at least one pair of a first pair of values of a sub-pixel located at a $1/2^{N-1}$ unit horizontal and unit vertical location, and a sub-pixel located at a unit horizontal and $1/2^{N-1}$ unit vertical location and a second pair of values of a pixel located at a unit horizontal and unit vertical location, and a sub-pixel located at a $1/2^{N-1}$ unit horizontal and $1/2^{N-1}$ unit vertical location.

23. A video coder for coding an image comprising pixels arranged in rows and columns and represented by values having a specified dynamic range, the pixels in the rows residing at unit horizontal locations and the pixels in the columns residing at unit vertical locations, the video coder comprising an interpolator adapted to generate values for sub-pixels at fractional horizontal and vertical locations, the fractional horizontal and vertical

locations being defined according to 1/2x, where x is a positive integer having a maximum value N, the interpolator being adapted to:

a) interpolate values for sub-pixels at $1/2^{N-1}$ unit horizontal and unit vertical locations, and unit horizontal and $1/2^{N-1}$ unit vertical locations directly using weighted sums of pixels residing at unit horizontal and unit vertical locations;

b) interpolate values for sub-pixels at $1/2^{N-1}$ unit horizontal and $1/2^{N-1}$ unit vertical locations directly using a choice of a first weighted sum of values for sub-pixels residing at $1/2^{N-1}$ unit horizontal and unit vertical locations and a second weighted sum of values for sub-pixels residing at unit horizontal and $1/2^{N-1}$ unit vertical locations, the first and second weighted sums of values being calculated according to step (a); and

c) interpolate a value for a sub-pixel situated at a $1/2^{N}$ unit horizontal and $1/2^{N}$ unit vertical location by taking a weighted average of the value of a first sub-pixel or pixel situated at a $1/2^{N-m}$ unit horizontal and $1/2^{N-n}$ unit vertical location and the value of a second sub-pixel or pixel located at a $1/2^{N-p}$ unit horizontal and $1/2^{N-q}$ unit vertical location, variables m, n, p and q taking integer values in the range 1 to N such that the first and second sub-pixels or pixels are located diagonally with respect to the sub-pixel at $1/2^{N}$ unit horizontal and $1/2^{N}$ vertical location.

24. A video coder according to claim 23, comprising a video encoder.

25. A video encoder according to claim 23, comprising a video decoder.

26. A codec comprising the video encoder of claim 24 and the video decoder of claim 25.

27. A communications terminal comprising a video coder for coding an image comprising pixels arranged in rows and columns and represented by values having a specified dynamic range, the pixels in the rows residing at unit horizontal locations and the pixels in the columns residing at unit

vertical locations, the video coder comprising an interpolator adapted to generate values for sub-pixels at fractional horizontal and vertical locations, the fractional horizontal and vertical locations being defined according to $1/2^x$, where x is a positive integer having a maximum value N, the interpolator being adapted to:

a) interpolate values for sub-pixels at $1/2^{N-1}$ unit horizontal and unit vertical locations, and unit horizontal and $1/2^{N-1}$ unit vertical locations directly using weighted sums of pixels residing at unit horizontal and unit vertical locations;

b) interpolate values for sub-pixels at $1/2^{N-1}$ unit horizontal and $1/2^{N-1}$ unit vertical locations directly using a choice of a first weighted sum of values for sub-pixels residing at $1/2^{N-1}$ unit horizontal and unit vertical locations and a second weighted sum of values for sub-pixels residing at unit horizontal and $1/2^{N-1}$ unit vertical locations, the first and second weighted sums of values being calculated according to step (a); and

c) interpolate a value for a sub-pixel situated at a $1/2^N$ unit horizontal and $1/2^N$ unit vertical location by taking a weighted average of the value of a first sub-pixel or pixel situated at a $1/2^{N-m}$ unit horizontal and $1/2^{N-n}$ unit vertical location and the value of a second sub-pixel or pixel located at a $1/2^{N-p}$ unit horizontal and $1/2^{N-q}$ unit vertical location, variables m, n, p and q taking integer values in the range 1 to N such that the first and second sub-pixels or pixels are located diagonally with respect to the sub-pixel at $1/2^N$ unit horizontal and $1/2^N$ vertical location.

28. A communications terminal according to claim 27 comprising a video encoder.

29. A communications terminal according to claim 27 comprising a video decoder.

30. A communications terminal according to claim 27 having a video codec comprising a video encoder and a video decoder.

31. A telecommunications system comprising a communications terminal and a network, the telecommunications network and the communications terminal being connected by a communications link over which coded video can be transmitted, the communications terminal comprising a video coder for coding for coding an image comprising pixels arranged in rows and columns and represented by values having a specified dynamic range, the pixels in the rows residing at unit horizontal locations and the pixels in the columns residing at unit vertical locations, the video coder comprising an interpolator adapted to generate values for sub-pixels at fractional horizontal and vertical locations, the fractional horizontal and vertical locations being defined according to $1/2^x$, where x is a positive integer having a maximum value N, the interpolator being adapted to:

a) interpolate values for sub-pixels at $1/2^{N-1}$ unit horizontal and unit vertical locations, and unit horizontal and $1/2^{N-1}$ unit vertical locations directly using weighted sums of pixels residing at unit horizontal and unit vertical locations;

b) interpolate values for sub-pixels at $1/2^{N-1}$ unit horizontal and $1/2^{N-1}$ unit vertical locations directly using a choice of a first weighted sum of values for sub-pixels residing at $1/2^{N-1}$ unit horizontal and unit vertical locations and a second weighted sum of values for sub-pixels residing at unit horizontal and $1/2^{N-1}$ unit vertical locations, the first and second weighted sums of values being calculated according to step (a); and

c) interpolate a value for a sub-pixel situated at a $1/2^N$ unit horizontal and $1/2^N$ unit vertical location by taking a weighted average of the value of a first sub-pixel or pixel situated at a $1/2^{N-m}$ unit horizontal and $1/2^{N-n}$ unit vertical location and the value of a second sub-pixel or pixel located at a $1/2^{N-p}$ unit horizontal and $1/2^{N-q}$ unit vertical location, variables m, n, p and q taking integer values in the range 1 to N such that the first and second sub-pixels or pixels are located diagonally with respect to the sub-pixel at $1/2^N$ unit horizontal and $1/2^N$ vertical location.

32. A telecommunications system according to claim 31 which is a mobile telecommunications system comprising a mobile communications terminal and a wireless network, the connection between the mobile communications terminal and the wireless network being formed by a radio link.

33. A telecommunications system according to claim 31 in which the network enables the communications terminal to communicate with other communications terminals connected to the network over communications links between the other communications terminals and the network.

34. A telecommunications system comprising a communications terminal and a network, the telecommunications network and the communications terminal being connected by a communications link over which coded video can be transmitted, the network comprising a video coder for coding for coding an image comprising pixels arranged in rows and columns and represented by values having a specified dynamic range, the pixels in the rows residing at unit horizontal locations and the pixels in the columns residing at unit vertical locations, the video coder comprising an interpolator adapted to generate values for sub-pixels at fractional horizontal and vertical locations, the fractional horizontal and vertical locations being defined according to $1/2^x$, where x is a positive integer having a maximum value N, the interpolator being adapted to:

a) interpolate values for sub-pixels at $1/2^{N-1}$ unit horizontal and unit vertical locations, and unit horizontal and $1/2^{N-1}$ unit vertical locations directly using weighted sums of pixels residing at unit horizontal and unit vertical locations;

b) interpolate values for sub-pixels at $1/2^{N-1}$ unit horizontal and $1/2^{N-1}$ unit vertical locations directly using a choice of a first weighted sum of values for sub-pixels residing at $1/2^{N-1}$ unit horizontal and unit vertical locations and a second weighted sum of values for sub-pixels residing at unit horizontal and $1/2^{N-1}$ unit vertical locations, the first and second weighted sums of values being calculated according to step (a); and

c) interpolate a value for a sub-pixel situated at a $1/2^N$ unit horizontal and $1/2^N$ unit vertical location by taking a weighted average of the value of a first sub-pixel or pixel situated at a $1/2^{N-m}$ unit horizontal and $1/2^{N-n}$ unit vertical location and the value of a second sub-pixel or pixel located at a $1/2^{N-p}$ unit horizontal and $1/2^{N-q}$ unit vertical location, variables m, n, p and q taking integer values in the range 1 to N such that the first and second sub-pixels or pixels are located diagonally with respect to the sub-pixel at $1/2^N$ unit horizontal and $1/2^N$ vertical location.

35. A video coder for coding an image comprising pixels arranged in rows and columns and represented by values having a specified dynamic range, the pixels in the rows residing at unit horizontal locations and the pixels in the columns residing at unit vertical locations, the coder comprising an interpolator adapted to generate values for sub-pixels at fractional horizontal and vertical locations, the resolution of the sub-pixels being determined by a positive integer N, the interpolator being adapted to:

a) interpolate values for sub-pixels at $1/2^{N-1}$ unit horizontal and unit vertical locations, and unit horizontal and $1/2^{N-1}$ unit vertical locations directly using weighted sums of pixels residing at unit horizontal and unit vertical locations;

b) interpolate a value for a sub-pixel at a sub-pixel horizontal and sub-pixel vertical location is required directly using a choice of a first weighted sum of values for sub-pixels located at a vertical location corresponding to that of the sub-pixel being calculated and a second weighted sum of values for sub-pixels located at a horizontal location corresponding to that of the sub-pixel being calculated.

36. A video coder according to claim 35 in which the interpolator is further adapted to form the first weighted sum using the values of sub-pixels residing at $1/2^{N-1}$ unit horizontal and unit vertical locations and to use the first weighted sum to interpolate a value for a sub-pixel at $1/2^{N-1}$ unit horizontal and $1/2^N$ unit vertical location.

37. A video coder according to claim 35 in which the interpolator is further adapted to form the second weighted sum using the values of sub-pixels residing at unit horizontal and $1/2^{N-1}$ unit vertical locations and to use the second weighted sum to interpolate a value for a sub-pixel at $1/2^{N}$ unit horizontal and $1/2^{N-1}$ unit vertical location.

38. A method according to claim 35 in which the interpolator is further adapted to interpolate values for sub-pixels at $1/2^{N}$ unit horizontal and $1/2^{N}$ unit vertical locations by taking the average of at least one pair of a first pair of values of a sub-pixel located at a $1/2^{N-1}$ unit horizontal and unit vertical location, and a sub-pixel located at a unit horizontal and $1/2^{N-1}$ unit vertical location and a second pair of values of a pixel located at a unit horizontal and unit vertical location, and a sub-pixel located at a $1/2^{N-1}$ unit horizontal and $1/2^{N-1}$ unit vertical location.

39. A video coder according to claim 35, comprising a video encoder.

40. A video encoder according to claim 35, comprising a video decoder.

41. A codec comprising the video encoder of claim 39 and the video decoder of claim 40.

42. A communications terminal comprising a video coder for coding an image comprising pixels arranged in rows and columns and represented by values having a specified dynamic range, the pixels in the rows residing at unit horizontal locations and the pixels in the columns residing at unit vertical locations, the coder comprising an interpolator adapted to generate values for sub-pixels at fractional horizontal and vertical locations, the resolution of the sub-pixels being determined by a positive integer N, the interpolator being adapted to:

a) interpolate values for sub-pixels at $1/2^{N-1}$ unit horizontal and unit vertical locations, and unit horizontal and $1/2^{N-1}$ unit vertical locations directly using weighted sums of pixels residing at unit horizontal and unit vertical locations;

b) interpolate a value for a sub-pixel at a sub-pixel horizontal and sub-pixel vertical location is required directly using a choice of a first weighted sum of values for sub-pixels located at a vertical location corresponding to that of the sub-pixel being calculated and a second weighted sum of values for sub-pixels located at a horizontal location corresponding to that of the sub-pixel being calculated.

43. A communications terminal according to claim 42 comprising a video encoder.

44. A communications terminal according to claim 42 comprising a video decoder.

45. A communications terminal according to claim 42 having a video codec comprising a video encoder and a video decoder.

46. A telecommunications system comprising a communications terminal and a network, the telecommunications network and the communications terminal being connected by a communications link over which coded video can be transmitted, the communications terminal comprising a video coder for coding an image comprising pixels arranged in rows and columns and represented by values having a specified dynamic range, the pixels in the rows residing at unit horizontal locations and the pixels in the columns residing at unit vertical locations, the coder comprising an interpolator adapted to generate values for sub-pixels at fractional horizontal and vertical locations, the resolution of the sub-pixels being determined by a positive integer N, the interpolator being adapted to:

a) interpolate values for sub-pixels at $1/2^{N-1}$ unit horizontal and unit vertical locations, and unit horizontal and $1/2^{N-1}$ unit vertical locations directly using weighted sums of pixels residing at unit horizontal and unit vertical locations;

b) interpolate a value for a sub-pixel at a sub-pixel horizontal and sub-pixel vertical location is required directly using a choice of a first weighted sum of values for sub-pixels located at a vertical location corresponding to that of the sub-pixel being calculated and a second weighted sum of values for sub-pixels located at a horizontal location corresponding to that of the sub-pixel being calculated.

47. A telecommunications system according to claim 46 which is a mobile telecommunications system comprising a mobile communications terminal and a wireless network, the connection between the mobile communications terminal and the wireless network being formed by a radio link.

48. A telecommunications system according to claim 46 in which the network enables the communications terminal to communicate with other communications terminals connected to the network over communications links between the other communications terminals and the network.

49. A telecommunications system comprising a communications terminal and a network, the telecommunications network and the communications terminal being connected by a communications link over which coded video can be transmitted, the network comprising a video coder for coding for coding an image comprising pixels arranged in rows and columns and represented by values having a specified dynamic range, the pixels in the rows residing at unit horizontal locations and the pixels in the columns residing at unit vertical locations, the coder comprising an interpolator adapted to generate values for sub-pixels at fractional horizontal and vertical locations, the resolution of the sub-pixels being determined by a positive integer N, the interpolator being adapted to:

a) interpolate values for sub-pixels at $1/2^{N-1}$ unit horizontal and unit vertical locations, and unit horizontal and $1/2^{N-1}$ unit vertical locations directly using weighted sums of pixels residing at unit horizontal and unit vertical locations;

b) interpolate a value for a sub-pixel at a sub-pixel horizontal and sub-pixel vertical location is required directly using a choice of a first weighted sum of values for sub-pixels located at a vertical location corresponding to that of the sub-pixel being calculated and a second weighted sum of values for sub-pixels located at a horizontal location corresponding to that of the sub-pixel being calculated.